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Length-weight Relationship and Condition Factor of Siluriformes Fish Species, Endangered *Eutropiichthys vacha*, Hamilton (1922) and Endemic Deccan Catfish *Rita kuturnee* (Sykes, 1839) of Godavari River Andhra Pradesh, South India

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ABSTRACT

Background: The present study of the length-weight relationship and condition factors of two *Eutropiichthys vacha* and *Rita kuturnee*, from Godavari River Andhra Pradesh, from the year August 2021 to July 2023 at fortnightly intervals.

Methods: The log transformation formula was employed to establish length-weight relationships (LWRs) [3]. The length-weight equation used was $W = aL^b$, in the usual notations. Linear regression of the log-transformed equation, log(W) = log(a) + b log(L), was utilized to calculate the parameters 'a' (intercept) and 'b' (slope) of the relationship.

Result: A total of 1453 specimens of *E. vacha* and 1273 specimens of *R. kuturnee* were collected by using gill nets. The collected specimens exhibited a total length range of 10 to 27 cm for *E. vacha* and 7 to 18.5 cm for *R. kuturnee*. Correspondingly, the body weight range was recorded as 12 to 140 gm for *E. vacha* and 8 to 50 gm for *R. kuturnee*. Statistical analysis revealed a negative allometric growth trend for both males and females of *E. vacha* and *R. kuturnee*, with b values ranging from 2.569 to 2.711 for *E. vacha* and 2.53 to 2.61 for *R. kuturnee*. The fluctuation in the relative condition factor ranged from 1.06 to 1.09 for *E. vacha* and 1.001 to 1.12 for *R. kuturnee*. Furthermore, the overall health conditions of these two species were determined to be favorable.

Key words: Allometric growth, Condition factor, Fishes, Length-weight relationship.

INTRODUCTION

The length-weight relationship is a fundamental parameter that provides valuable information regarding the fish stock's condition. Fisheries management and conservation efforts rely on accurate knowledge of body weight for regulating catches and estimating biomass. The asymptotic weight is one the important parameter for fitting yield models in population dynamics. The relationship between weight (W) and length (L) can be represented by the length-weight relationship (LWR) equation:

$$W = a L^b$$

Where,
W = Denotes weight.
L = Represents length.
a and b = Constants specific to each species.

Understanding this relationship provides information on fish population growth and condition, as well as possible changes caused by environmental factors such as habitat deterioration, pollution and resource availability. It is also beneficial for comparing the life histories and morphological characteristics of populations from different regions (Stergiou and Moutopoulos, 1951; Gonçalves *et al.,* 1997).

The condition factor, a crucial parameter, serves as an indicator of the general well-being and nutritional status of fish, providing insights into variations in fish condition through deviations from the expected values obtained by calculating the ratio of observed weight to the expected

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weight for a given length. Multiple factors, including food availability, competition, habitat quality and reproductive activities, exert influence on the condition of fish. By assessing the condition factor, can effectively evaluate the holistic health and vitality of fish populations, thereby identifying potential stressors or disturbances within their environment. This study focuses on the two significant fish species, *E. vacha* and *R. kuturnee*, inhabiting the Godavari River. To date, no scientific investigations have been conducted on the length-weight relationships and condition factors of *E. vacha* and *R. kuturnee* specifically within the Godavari River. Consequently, undertaking an examination of the length-weight relationships and condition factors of these species will contribute to advancing our comprehension of their growth dynamics and facilitate the formulation of suitable conservation strategies.

MATERIALS AND METHODS

This study was conducted in the Godavari River (Fig 1) Andhra Pradesh, from the year August 2021 to July 2023 at fortnightly intervals. Fish samples were collected for the research with the help of local fishermen. Morphometric measurements such as total length (TL) were measured to the nearest millimeter and total weight (W) was recorded to the nearest milligram. The log transformation formula was employed to establish length-weight relationships (LWRs) (Le Cren, 1951). The length-weight equation used was $W = aL^b$, in the usual notations in gm and cm respectively. Linear regression of the log-transformed equation was utilized to calculate the parameters 'a' (intercept) and 'b' (slope) of the relationship.

$$\log (W) = \log(a) + b \log(L)$$

The coefficient of determination (r^2) was calculated to evaluate the predictive quality of the linear regression model. The relative condition factor (Kn) was determined to assess the growth condition of the fish species. Kn is defined as:

Kn = Wo/Wc,

Where,

Wo = Observed weight.

Wc = Calculated weight (Le Cren, 1951).

A Kn value of ≥1 indicates a good growth condition, while a Kn value of <1 suggests a poor growth condition compared to an average individual of the same length.

RESULTS AND DISCUSSION

Table 1 and Fig 2 present the statistical analysis of various parameters including sample size (number of observed specimens), total length (TL), body weight (BW) and length-weight relationship (LWR) parameters 'a' and 'b' with 95% confidence intervals, coefficient of determination (r^2) and condition factor for both male and female individuals of *E. vacha* and *R. kuturnee*. In this study, a total of 1453 *E. vacha* individuals were examined, comprising 732 males and 721 females. The TL of male *E. vacha* ranged from 10 cm to 25 cm, while that of females ranged from 11 cm to 27 cm.

Table 1: Descriptive statistics and estimated relationships between the total length (cm) and weight (g) (LWRs) of *E. vacha* and *R. kuturnee* collected from Godavari River Andhra Pradesh.

	Sex	Total length (cm)		Total weight (g)		a	(95% CL of a)	b	(95% CL of b)	R^2	Kn
		Min	Max	Min	Max						
Eutropiichthys vacha	Male	10	25	12	124.3	0.0204	0.0176-0.0231	2.619	2.5735-2.6649	0.9454	1.090.93-1.22
	Female	11	27	15	140	0.014	0.0123-0.0173	2.711	2.656-2.767	0.927	1.0600.901-1.347
	pooled	10	27	12	140	0.022	0.0198-0.0265	2.569	2.5209-2.6174	0.882	1.070.915-1.19
Rita Kuturnee	Male	7	18	8	42	0.096	0.0875-0.1044	2.56	2.5243-2.5956	0.9575	1.012 0.857-1.39
	Female	8	18.5	9	50	0.086	0.0771-0.0956	2.53	2.501-2.5646	0.921	1.120.975-1.28
	Pooled	7	18.5	8	50	0.091	0.0848-0.0971	2.61	2.5831-2.6368	0.905	1.0010.942-1.13

The total length (TL) for *E. vacha* was reported as 30.0 cm from Bangladesh (Rahman, 1989) and 37.00 cm from the Ganga River, India (Tripathi and Gopesh, 2017). Compare to the present study lower lengths were recorded from the Jamuna River, Bangladesh *i.e*, 16.95 cm (Sungai *et al.,* 2013), 25.8 cm in the lower part of the Ganges River (Hossain *et al.,* 2009) and 21.50 cm in the Gomti River (Sani *et al.,* 2010). The observed variations in TL can be attributed to geographical location and environmental factors, particularly water temperature and food availability (Hossain and Ohtomi, 2010). For *R. kuturnee*, a total of 1273 individuals were examined, including 644 males and 629 females. The TL of male *R. kuturnee* ranged from 7 cm to 18 cm, while that of females ranged from 8 cm to 18.5 cm.

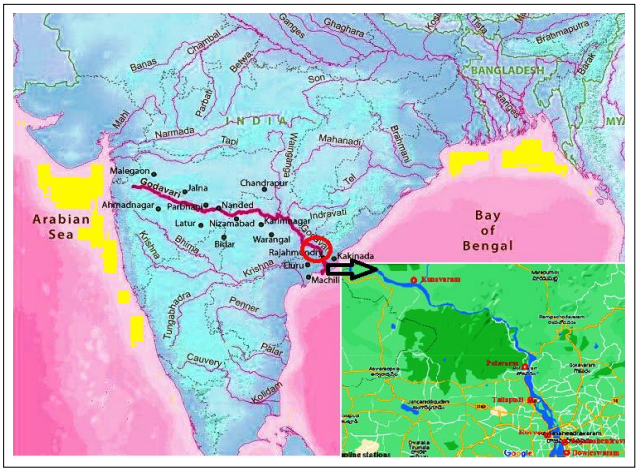

Fig 1: Map showing sampling area in Godavari River Andhra Pradesh.

The 'b' values estimated and analysis of variance for female, male and pooled sexes of *E. vacha* and *R. kuturnee* (Table 2 and 3) fell within the expected range of 2.5-3.5 and their no significant difference between both of fish species growth (Froese, 2006). These values were significantly lower than 3, suggesting a negative allometric growth pattern, which could be attributed to a narrow size range observed in these fish species. The correlation coefficient values (r^2) for the length-weight regression ranged from 0.88 to 0.94. These high positive correlation coefficients indicate a strong relationship between total length and total weight, indicating that as the species' size increases, so does its weight. Similar negative allometric growth pattern for the combined sexes of *E. vacha* in the Padma (lower Ganges River) River, Bangladesh (Hossain *et al.,* 2006, 2009, 2010). Furthermore,

Table 2: ANOVA analysis of the species of *E. vacha.*

ANOVA	df	SS	MS	F	Significance F
Male *E. vacha*					
Regression	1	38.39082	38.39082	12660.54	0
Residual	729	2.210561	0.003032		
Total	730	40.60139			
Female *E. vacha*					
Regression	1	40.58058	40.58058	9165.977	0
Residual	718	3.178805	0.004427		
Total	719	43.75938			
Pooled *E. vacha*					
Regression	1	75.45487	75.45487	10911.78	0
Residual	1450	10.02674	0.006915		
Total	1451	85.4816			

Table 3: ANOVA analysis of the species of *R. kuturnee.*

ANOVA	df	SS	MS	F	Significance F
***R. kuturnee* (Male)**					
Regression	1	15.22438	15.22438	14261.33	0
Residual	641	0.684286	0.001068		
Total	642	15.90866			
***R. kuturnee* (Female)**					
Regression	1	16.47044	16.47044	10894.83	0
Residual	626	0.946366	0.001512		
Total	627	17.41681			
***R. kuturnee* (Pooled)**					
Regression	1	32.29688	32.29688	25612.09	0
Residual	1271	1.602732	0.001261		
Total	1272	33.89961			

negative allometric growth was reported for the female population from the Jamuna River, Bangladesh (Hossain *et al.,* 2016) and the Indus River, Pakistan (Soomro *et al.,* 2007; Sungai *et al.,* 2013). A negative allometric growth pattern was noticed for both male (b = 2.83) and female (b = 2.78) populations of *E. vacha* from the Ganga River in northwestern Bangladesh (Khatun *et al.,* 2018). Conversely, isometric growth (Soomro *et al.,* 2007) and positive allometric growth pattern (Sungai *et al.,* 2013) for male populations of *E. vacha* from the Jamuna River, Bangladesh and Indus River, Pakistan, respectively.

The condition factor, which is influenced by both biotic and abiotic environmental factors, serves as a valuable indicator for monitoring feeding intensity, growth rates and fish population (Oni *et al.,* 1983; Blackwell *et al.,* 2000). Additionally, it can be utilized as an index to assess the overall condition of the aquatic ecosystem in which the fish habitat exists (Barnham and Baxter, 1998). The condition factor (Kn), close to or equal to 1 indicates a satisfactory fitness level for fish species (Le Cren, 1951; Jisr *et al.,* 2018). The study revealed that the relative condition factor (Kn) for male, female and pooled sex *E. vacha* was found to be 1.09, 1.060 and 1.07 respectively. Similarly, for *R. kuturnee*, the Kn values varied between males (1.012) and females (1.12), with a pooled sex ratio Kn value closer to the ideal condition (1.001). These findings indicate that Kn values greater than 1 are associated with good growth conditions, suggesting that these fish thrive in favorable environments. Previous studies for *E. vacha* in the Padma River, northwestern Bangladesh, reported that the Kn values ranged from 0.78 to 1.12 for males, 1.0 to 1.29 for females and 0.9 to 1.28 for combined sexes (Hossain, 2010). Similarly, the relative condition factor for *E. vacha* in the Ganga River, northwestern Bangladesh, with a range of 0.7747 to 1.49

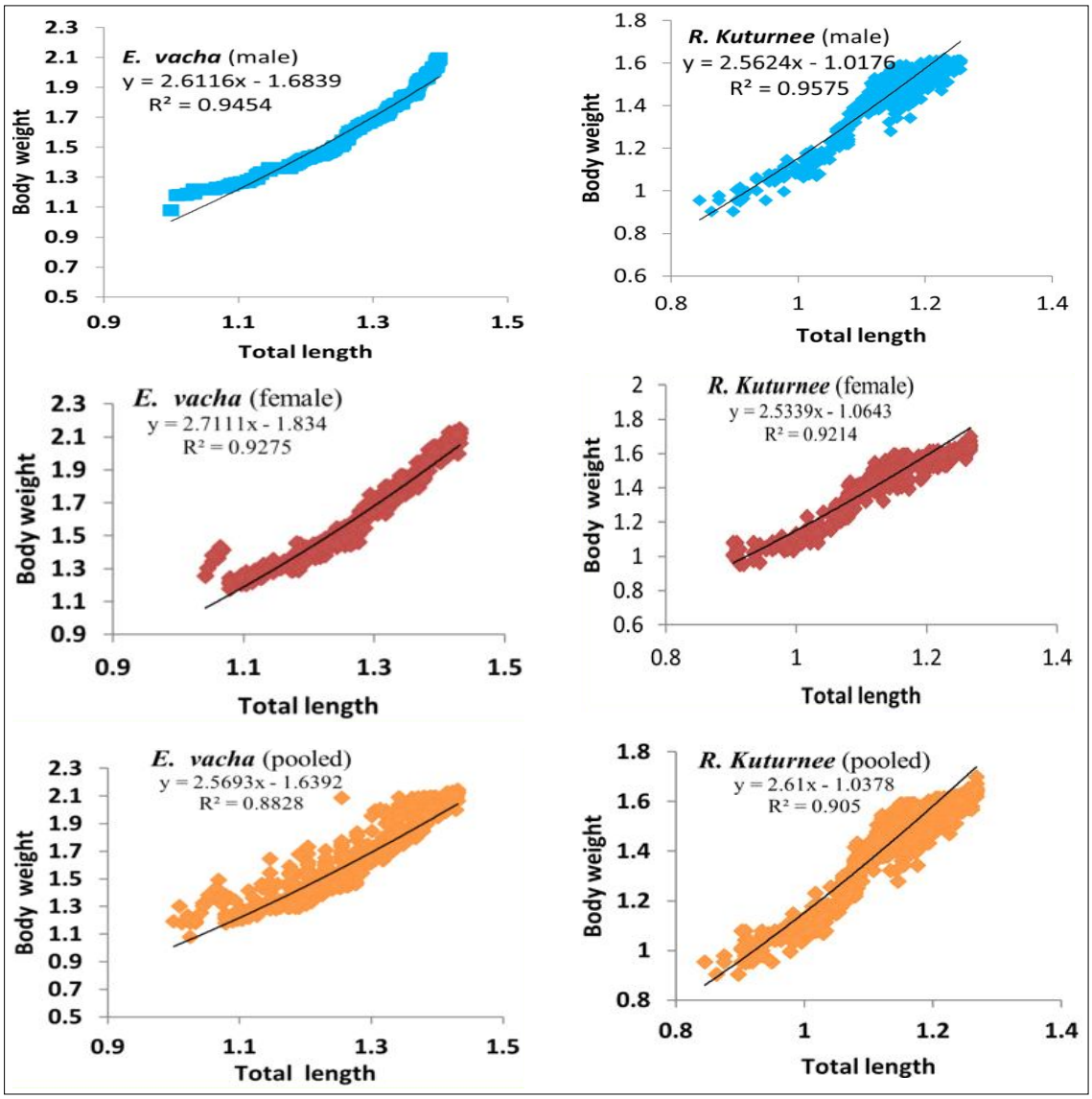

Fig 2: Length-weight relationships of two species collected from Godavari River Andhra Pradesh.

for males, 0.39 to 0.6654 for females and 0.7552 to 1.457 for combined sexes (Khatun *et al.,* 2018).

The observed variations in length-weight relationship (LWR) and condition factors can be attributed to several factors such as sex, gonad ripeness, habitat availability, seasonal effects, level of stomach fullness, fish health, preservation method and variations in the length class under examination (Sungai *et al.,* 2013). It is important to note that the present study did not take into account any of these influential factors on LWRs and condition factors in the studied fishes (Ferosekhan *et al.,* 2022; Sarkar *et al.,* 2013).

CONCLUSION AND ACKNOWLEDGMENT

The length-weight relationship (LWR) and condition factor (Kn) data are currently lacking for *Rita kuturnee*, with available information limited to *Rita rita* and *R. chrysea*. However, Limited information is available on LWRs and Kn for *E. vacha*. Hence these data provide baseline information for various biological studies aimed at assessing the sustainability of fishery production and managing their populations effectively. The first author would like to thank the Dean of Dr. M.G.R Fisheries College and Research Institute Ponneri for their constant support, encouragement and facilities provided during the study period.

Author's contribution

The design and structuring of the article's topic involved input from all of the authors. P. Jawahar came up with the idea for the subject and set of review articles. N. Jayakumar proposed it after reviewing the original script. Up until the final text, all authors must be read, suggested and given a lot of assistance.

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Data availability

The present information is searched and analyzed by the corresponding author.

Code availability

Not applicable.

Declarations

Ethical approval

Not applicable.

Consent to participate

Not applicable.

Consent to publication

Not applicable.

Conflict of interest

The author declares that they have no conflicts of interest.

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